

國立臺灣科技大學

114學年度碩士班招生

試題

系所組別：0350機械工程系碩士班戊組

科目：材料原理

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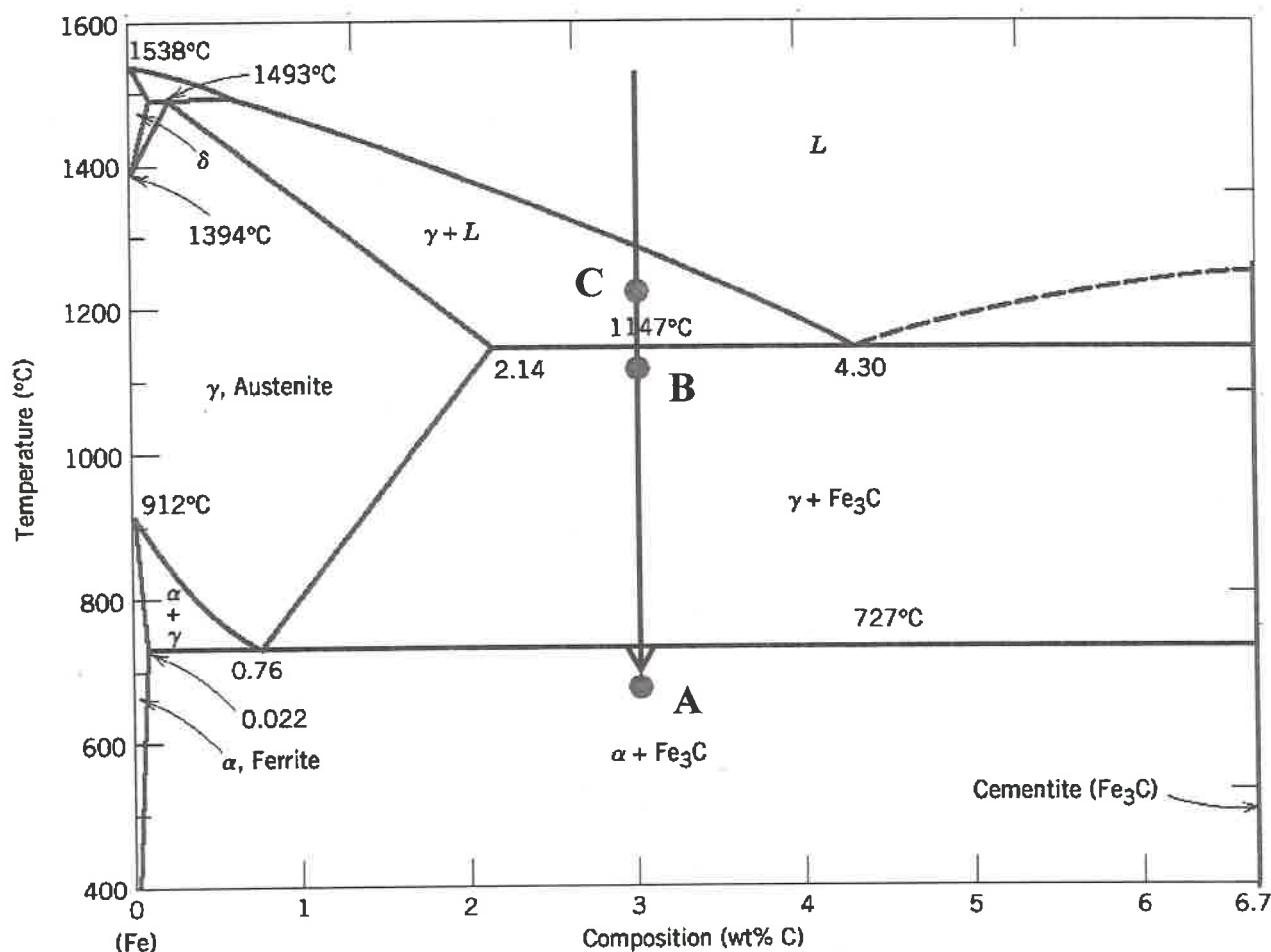
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(總分為 100 分；所有試題務必於答案卷內頁依序作答)

- (25%) A free aluminium (Al) atom has a radius of 1.43×10^{-8} cm and atomic mass of 26.98 g/mol. With the three outermost electrons removed, the radius shrinks to 39 pm for a 4-coordinated atom or 53.5 pm for a 6-coordinated atom. At standard temperature and pressure, aluminium atoms (when not affected by atoms of other elements) form a face-centered cubic (FCC) crystal system bound by metallic bonding provided by atoms' outermost electrons; hence aluminium (at these conditions) is a metal.
 - (5%) Please draw a FCC for a Al metal.
 - (5%) What is the coordination number of Al in a FCC structure?
 - (5%) What is the atomic packing factor of FCC-Al? A calculation process is needed.
 - (10%) What is the density (g/cm^3) of FCC-Al? A calculation process is needed.
- (10%) 請說明下列反應式中，哪個物質中的哪個元素(或離子)發生氧化(oxidation)反應? 哪個物質中的哪個元素(或離子)發生還原(reduction)反應?
 - (5%) $2\text{MgCl}_2 + \text{O}_2 \rightarrow 2\text{MgO} + 2\text{Cl}_2$
 - (5%) $\text{Pb} + \text{PbO}_2 + 2\text{H}_2\text{SO}_4 \rightarrow 2\text{PbSO}_4 + 2\text{H}_2\text{O}$
- (5%) 請描述單晶、多晶和非晶固體之間的微結構差異。
- (10%) A phase diagram of Fe-C alloy with the composition of 3 wt.% C is shown below.
 - (5%) What compositions are all the phases present for the point A marked in the Fe-C diagram?
 - (5%) Calculate the relative fractions of the present phases for the same point A marked.



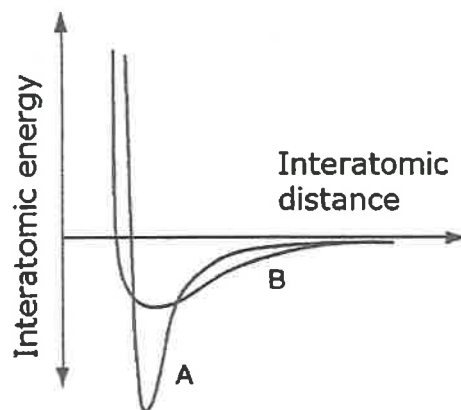
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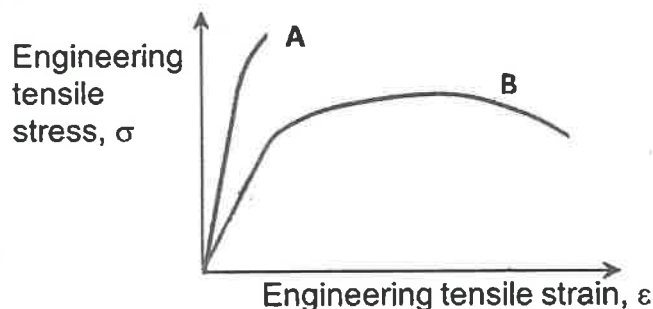
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(總分為 100 分；所有試題務必於答案卷內頁依序作答)

5. (10%) Magnesium (Mg) and Zirconium dioxide (ZrO_2) are common engineering materials. Their interatomic energy curves are shown in the following Figure. Please answer the following questions:
- (a) (5%) Which curve in the Figure does ZrO_2 belong to? Please explain briefly.
- (b) (5%) Which material will have the higher thermal expansion coefficient? Please explain briefly.



6. (10%) When Al_2O_3 (as an impurity) is added into MgO , Al^{3+} ion will substitute Mg^{2+} ion.
- (a) (5%) What kind of point defects are possibly formed in order to maintain charge neutrality?
- (b) (5%) How many Al^{3+} ions must be added to form each of these defects?
7. (10%) The stress-strain curves are shown below for metal A and B. The specimens used in the tensile test have the same diameter and length. Please answer the following questions.
- (a) (5%) Which one has the higher modulus of elasticity? Why?
- (b) (5%) Which one shows higher toughness? Why?



8. (20%) If you are an engineer responsible for 12-inch silicon single crystal growing,
- (a) (10 points) how do you grow a P-type Si single crystal and a n-type Si single crystal? You have elements (B, Ge, P) to choose as the dopant. Can you explain which element is a donor and which is an acceptor? Please explain why the crystal is P-type or n-type?
- (b) If you fabricate a p-n junction, and you apply a forward-bias and/or a reverse bias, What is the voltage-current curve for this device? Please explain schematically. (5 points)
- (c) Can you use an energy band structure to describe the energy level of a p-type and/or n-type semiconductor? (5 points)

